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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	
Donald W. Allen et al	
Serial No. 09/625,893	Group Art Unit: 3673
Filed: July 26, 2000	Examiner: K. Mitchell
SMOOTH SLEEVES FOR DRAG AND VIV REDUCTION OF CYLINDRICAL STRUCTURES	June 14, 2005

DECLARATION OF DR. DONALD W. ALLEN

I, Dr. Donald Wayne Allen declare as follows:

1. My name is Dr. Donald Wayne Allen. I am presently the Business Team Manager of the Pipelines Business Group for Shell Global Solutions (U.S.) and named inventor on the above-referenced patent application. I am more than 18 years of age, have not been convicted of a felony or a crime of moral turpitude, am of sound mind, and am competent to make this Declaration.

2. I received a B. S. in Mechanical Engineering from Texas A&M University in 1981, and a Ph. D. in Mechanical Engineering from Rice University in 1986. I have been a Staff Research Engineer – Offshore Structures for Shell since August 1986. I consult with various Shell and non-Shell entities regard the potential vortex-induced vibration ("VIV") problems with various subsea structures. In this role, I have performed VIV analyses of offshore and subsea structures such as production platforms, risers, riser bases, jumpers, tendons, spars, and pipeline spans.

3. I have performed research directed to the characterization of VIV conditions. I have also performed research directed to the development of VIV suppression devices, including various helical strake systems, fairing systems and shroud or covering systems. This research includes work performed at various Shell facilities located in Houston, Texas and at the Naval Surface Warfare Center, located in Caderock, Maryland.

4. I have authored and published a number of papers on the subject of VIV and its suppression, including a paper I co-authored with Dean Henning, entitled *Vortex-Induced Vibration Tests of a Flexible Smooth Cylinder at Supercritical Reynolds Numbers*, May 1997, (the "Allen Paper").

5. I have authored a number of patent applications and patents on the subject of VIV and its suppression including United States Patent Numbers 5,410,979; 5,421,413;

5,875,728; 6,092,483; 6,179,524; 6,196,768; 6,223,672; 6,227,137; 6,263,824; 6,309,141; 6,551,029; 6,561,734; 6,571,878; 6,644,894; 6,685,394; and 6,702,026.

6. I have reviewed the Office Action that was issued in the above-referenced application, in which the Examiner rejected claims 1-6 over my paper by itself, or over my paper in view of another reference.

7. With reference to the Allen Paper, the cylinders used in the paper were 78.5" in length. There was a single ABS cylinder used, which had an outside diameter of 3.5 in. There was a single PVC cylinder used which had an outside diameter of 5.5625 in. P. 681, col. 1, Test Setup. As may be readily determined, this resulted in cylinder surface areas of approximately 863.2 in^2 and 1371.8 in^2, respectively. The data presented in the Allen Paper details the PVC pipe as having an average k/D surface roughness of 9.94E-4, with samples in the ranging from 8.86E-5 to 1.09E-4 and the ABS cylinder having an average cylinder roughness k/D of 1.37E-4, with the samples ranging from 1.21E-4 to 1.51E-4. While the Allen Paper discusses cylinders having the above ranges, it is now clear to me that one could misconstrue the paper as indicating that there existed multiple pipes of each type. The tests were carried out with a single pipe of each type, with the surface roughness information being obtained from various samples from that single test pipe. While the following discussion focuses on the testing of the PVC cylinder, identical test methods were used to determine the roughness for the ABS pipe.

8. The methodology used to determine the surface roughness is as follows: Five 1 inch by 1 inch samples were cut from each pipe following the flow tests. The sites for the samples were arbitrarily selected. The approximately 1 in^2, was selected to permit a sample to be mounted on a microscope slide. The microscope then sampled 2mm x 2mm (0.0062 in^2) out of the 1 square inch. The total area sampled (0.031 in^2 5 multiplied by 0.0062 in^2) for the surface roughness test represents 0.00226 percent of the total surface area of the PVC pipe. The confocal scan of each sample using a laser microscope was performed at Shell's facilities at the Westhollow Technology Center.

9. The results of the 1995 tests for the PVC pipe are summarized below in Table 1.

Sample	R_a (μm)	R_a (in.)	R_q (μm)	R_q (in.)	k/D
1	14.42	5.58E-04	18.41	7.25E-04	1.02E-04
2	13.91	5.48E-04	17.97	7.07E-04	9.85E-05
3	12.52	4.93E-04	15.97	6.29E-04	8.86E-05
4	15.42	6.07E-04	19.57	7.70E-04	1.09E-04
5	13.94	5.49E-04	17.88	7.04E-04	9.87E-05
Mean	14.04	5.53E-04	17.96	7.07E-04	9.94E-05

Table 1

In Table 1, R_a is the integrated average peak to trough roughness, and R_q represents the scatter of roughness about the mean roughness. An Appendix is attached to this declaration setting forth the formulas for determining these parameters. As may be seen from Table 1, and the explanation within the Appendix, smoothness can vary significantly from sample to sample, as well as within a sample.

10. It is this variation, both within a sample and as from sample to sample, together with the relatively small sampling area, that leads me to believe based on a statistical analysis that at least 40% of the PVC pipe had a surface roughness of greater than 1.0E-4. By a

similar analysis, at least 95% of the ABS pipe had a surface roughness of greater than 1.0E-4.

11. Amended claims 1-6 recite a cylindrical element consisting of a surface having a K/D ratio of less than 1.0E-4 to reduce vortex induced vibration. Since at least 40% of the PVC pipe and 95% of the ABS pipe had a surface roughness of greater than 1.0E-4, those pipes were too rough to be effective in reducing vortex induced vibration. In contrast, in the examples in this application, I tested a smooth fiberglass cylinder having a K/D of 5.1E-5, which did provide suppression of VIV and drag, and was within the claim recitation of consisting of a surface having a K/D ratio of less than 1.0E-4.

12. I can explain the difference in response of the PVC and ABS cylinders in the Allen paper, and the smooth fiberglass cylinder of this application, as the PVC and ABS cylinders being too rough, not consisting of a surface having a K/D ratio of less than 1.0E-4, while the fiberglass cylinder was significantly smoother and did consist of a surface having a K/D ratio of less than 1.0E-4.

13. A single rough point, or a small number or percentage of rough areas on a cylinder having a K/D ratio of greater than 1.0E-4 would not interfere with the VIV and drag suppression. However, since the PVC pipe had a significant percentage of at least 40% of the surface area of the pipe having a K/D ratio of greater than 1.0E-4, VIV and drag suppression was adversely affected.

I am aware that willful false statements and the like are punishable by fine or imprisonment, or both under Title 18 U.S.C. §1001 and may jeopardize the validity of the application or any patent issuing hereon. All statements made herein are made based on my own knowledge are true and that all statements made on information and belief are believed to be true.

Donald W. Allen, Ph.D.

Date: ________________

Sharon S. Mello

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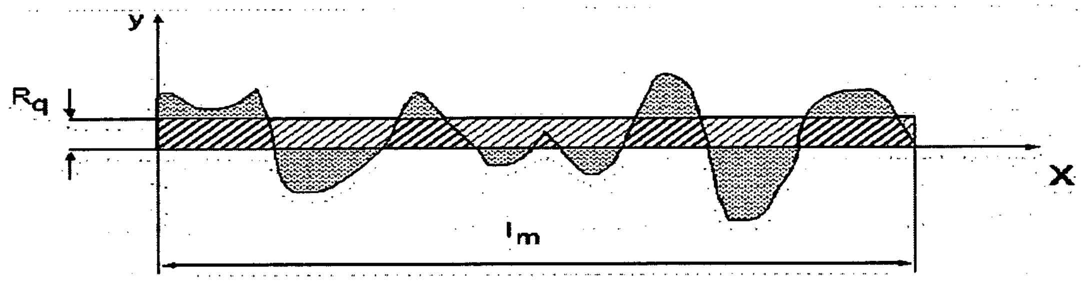
APPENDIX

Definitions of R_a, R_q

Surface, Rq value

This number represents the scatter of the amplitude values around the zero line. This value is calculated using the following formula:

$$R_q = \sqrt{\frac{1}{I_m}\int_0^{I_m} y^2(x)dx}$$

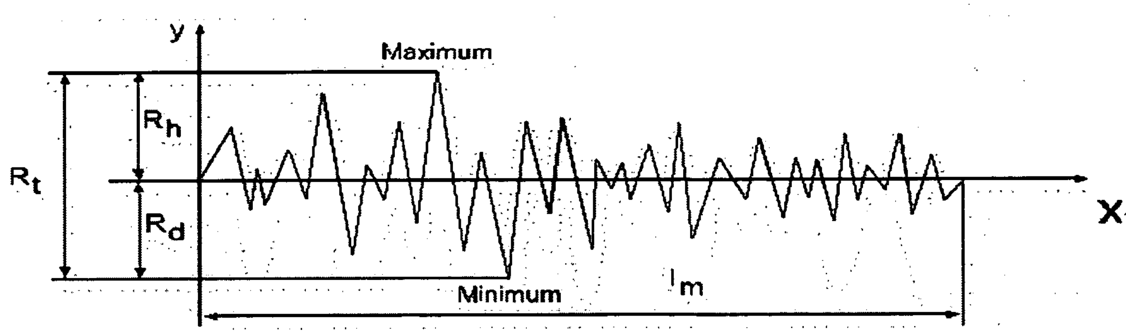


Surface, Rt, Rh, Rd values

These numbers represent the difference between maximum and minimum of a profile (span).

The values are calculated using the following formulae:

$$R_h = Maximum(y_i)$$
$$R_d = Minimum(y_i)$$
$$R_t = R_h - R_d$$



Surface, Ra value

This number represents the average peak-to-trough height of a measuring surface.
The average peak-to-trough height corresponds to the height of a rectangle the length of which is equal to the total measuring distance ***lm***
The surface area of the rectangle must be equal to the sum of the area enclosed between roughness profile and centerline.
The average peak-to-trough height is calculated using the following formula:

$$R_a = \frac{1}{I_m} \int_{x=0}^{x=I_m} |y| dx$$